Real-time Monitoring and Forecast Support for DYNAMO
(Challenges in forecasting the MJO)

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OUTLINE…

- Reminder of the importance of forecasting at the interface between weather and climate

- The DYNAMO campaign

- The NCEP/ESSIC monitoring and forecasting support

- Forecast challenges during DYNAMO:

  – Confronting the atmospheric model to DYNAMO observations

  – Coupled versus uncoupled forecasts at subseasonal time scales

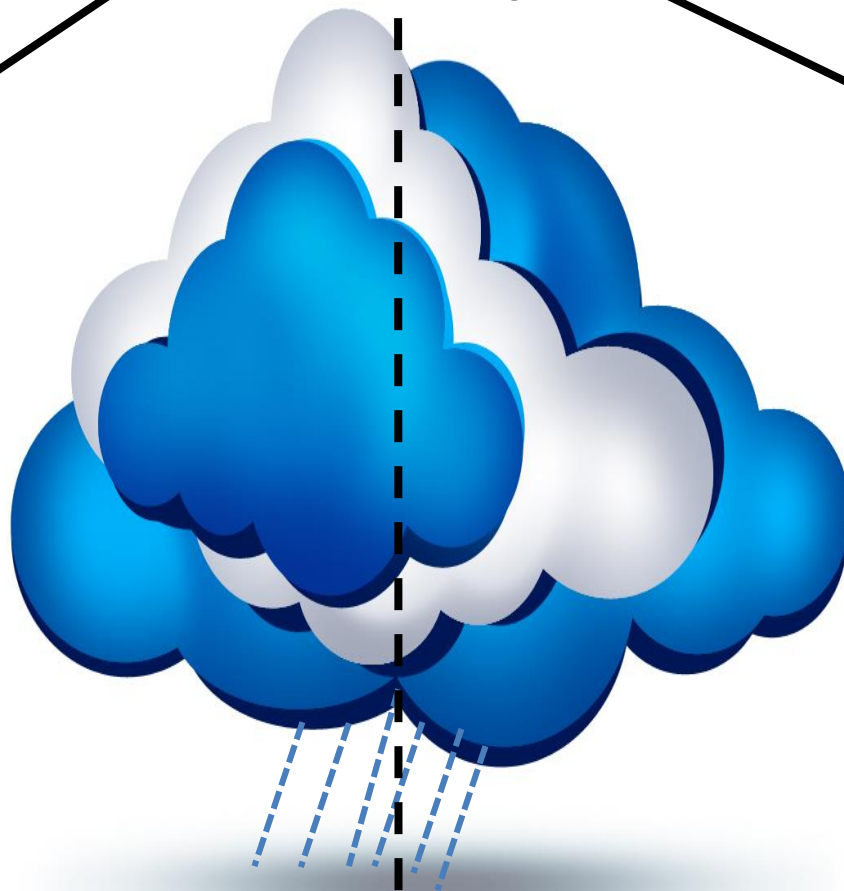 – Confronting the oceanic model to DYNAMO observations

- Conclusions

Tropical Subseasonal Variability

Weather forecasting

Modulation of probability of formation of Tropical Cyclones

Extreme precipitation events in the western CONUS

Climate forecasting

Affecting predictability of ENSO
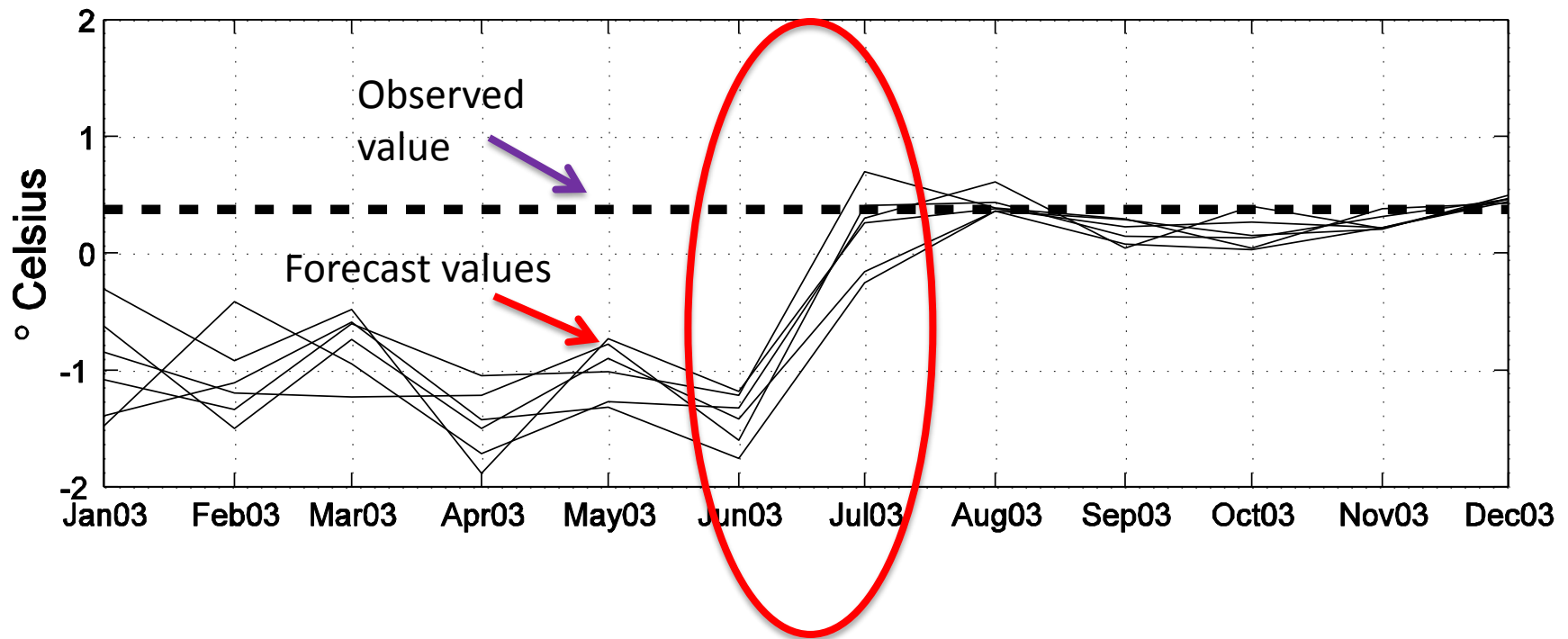
Modulating amplitude of ENSO

Week 2 – Week 4

Day 0 - Day 7

Season 1 – Year 1

Forecasting ENSO with the NASA model

Nino3 Index Forecast for December 2003

Observed intraseasonal activity modified the forecast from La Nina to neutral in just one month

(Vintzileos et al., 2005)

EL NIÑO/SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION
issued by
CLIMATE PREDICTION CENTER/NCEP/NWS
**and the International Research Institute for Climate and Society**

6 September 2012

ENSO Alert System Status: El Niño Watch

EL NIÑO/SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION
issued by
CLIMATE PREDICTION CENTER/NCEP/NWS
and the International Research Institute for Climate and Society

8 November 2012

ENSO Alert System Status: Not Active

Status of the MJO in August – September 2012

In early September 2012 the Forecaster was facing a collapsing MJO event over the Indian Ocean

RMM index 15/8/2012 - 30/9/2012
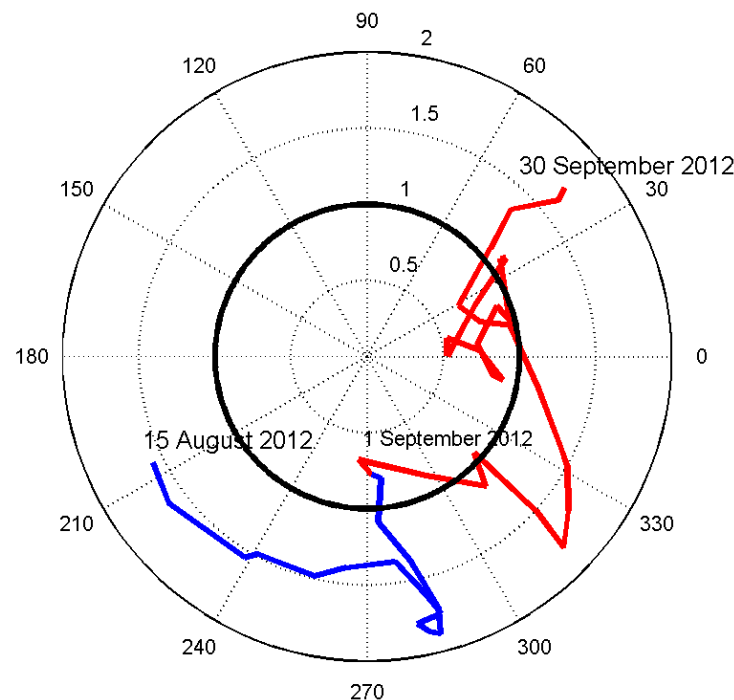
However, a few days later the MJO came back roaring, crossed the Maritime Continent and entered the western Pacific:

Need for MJO to ENSO research!!

The DYNAMO campaign:

Observations help to better understand subseasonal variability and face forecasting challenges

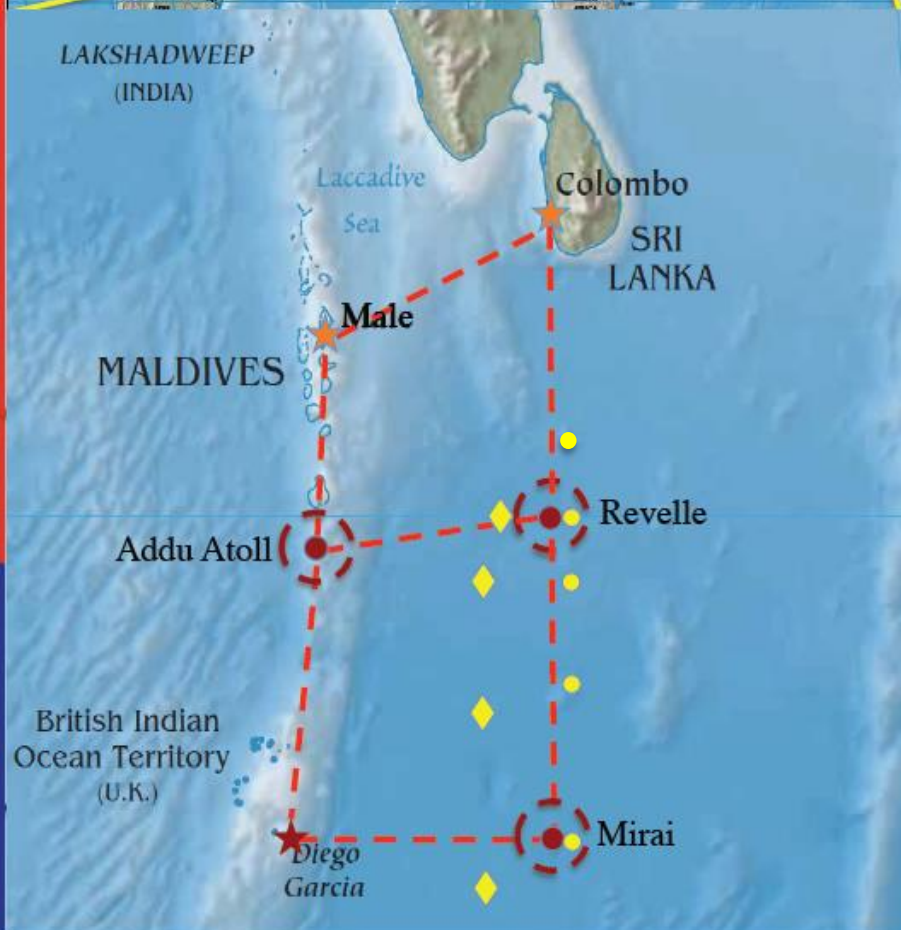CINDY/DYNAMO Field Campaign – 1/10/2011 to 31/3/2012
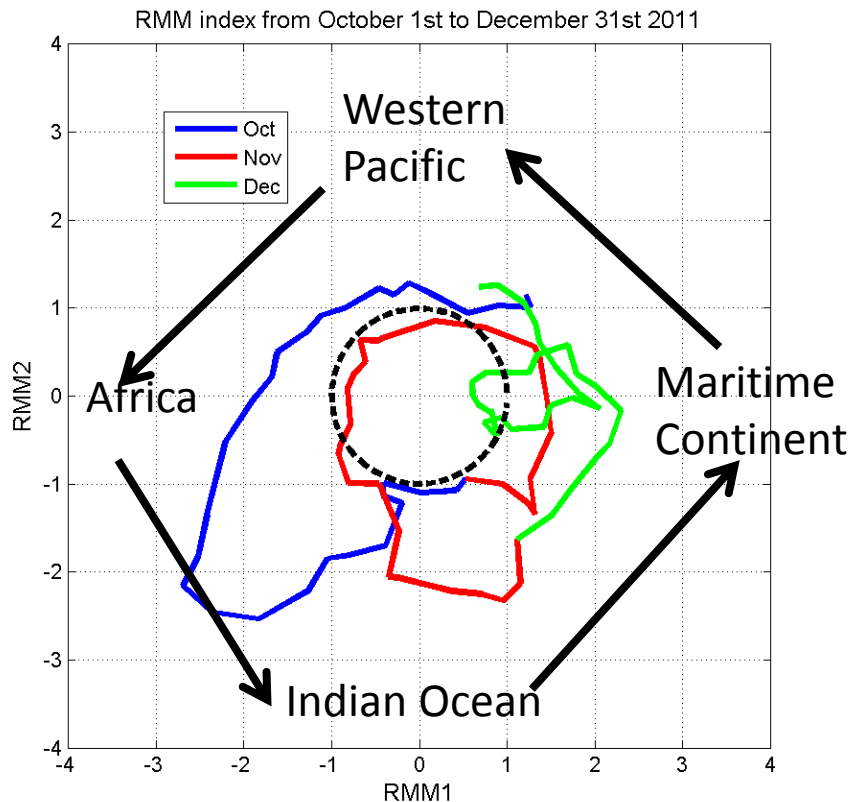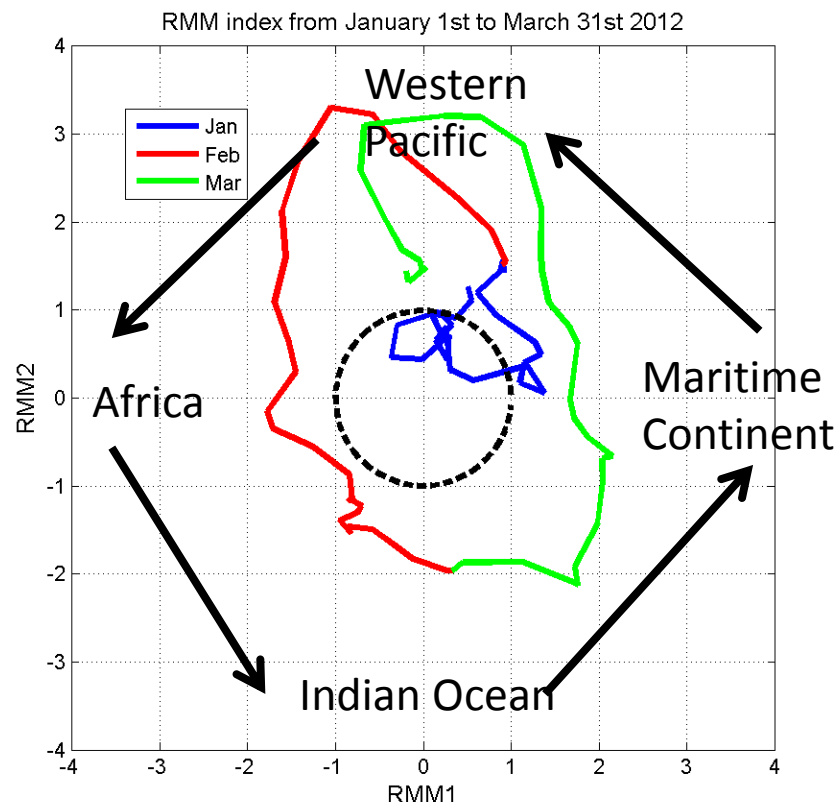
DYNAMO was a lucky campaign!

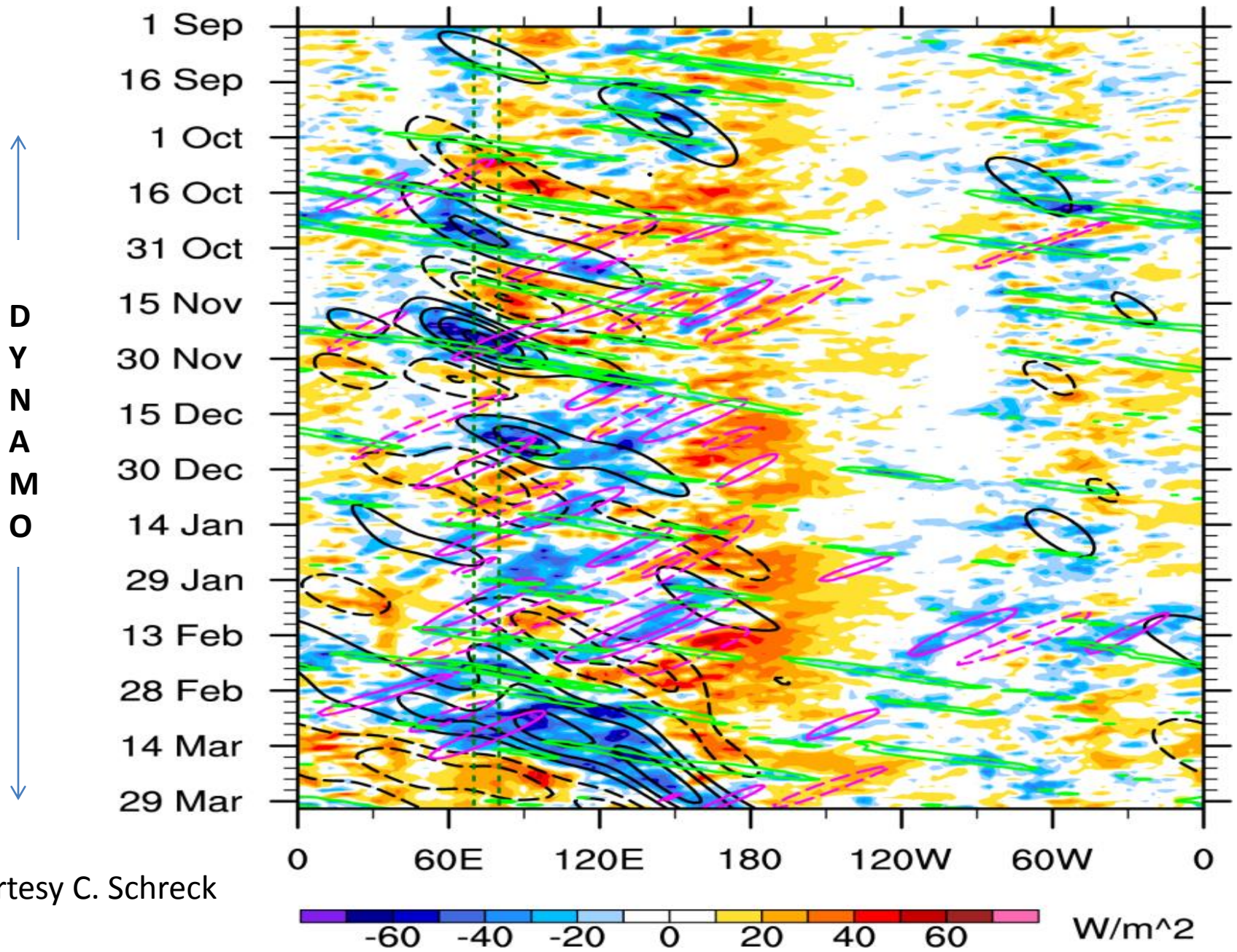## Review of DYNAMO through the RMM index

October to December 2011 — January to March 2012

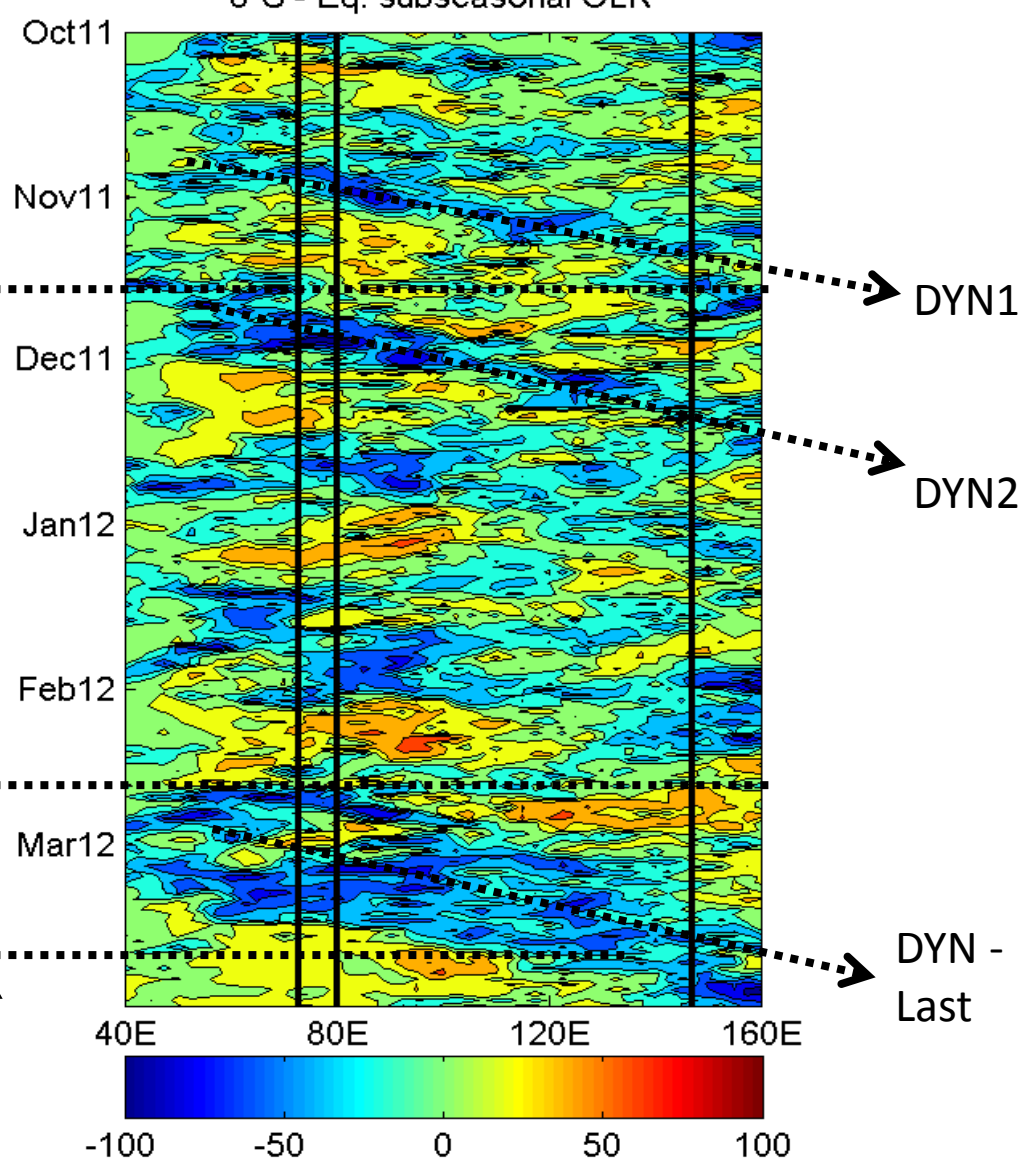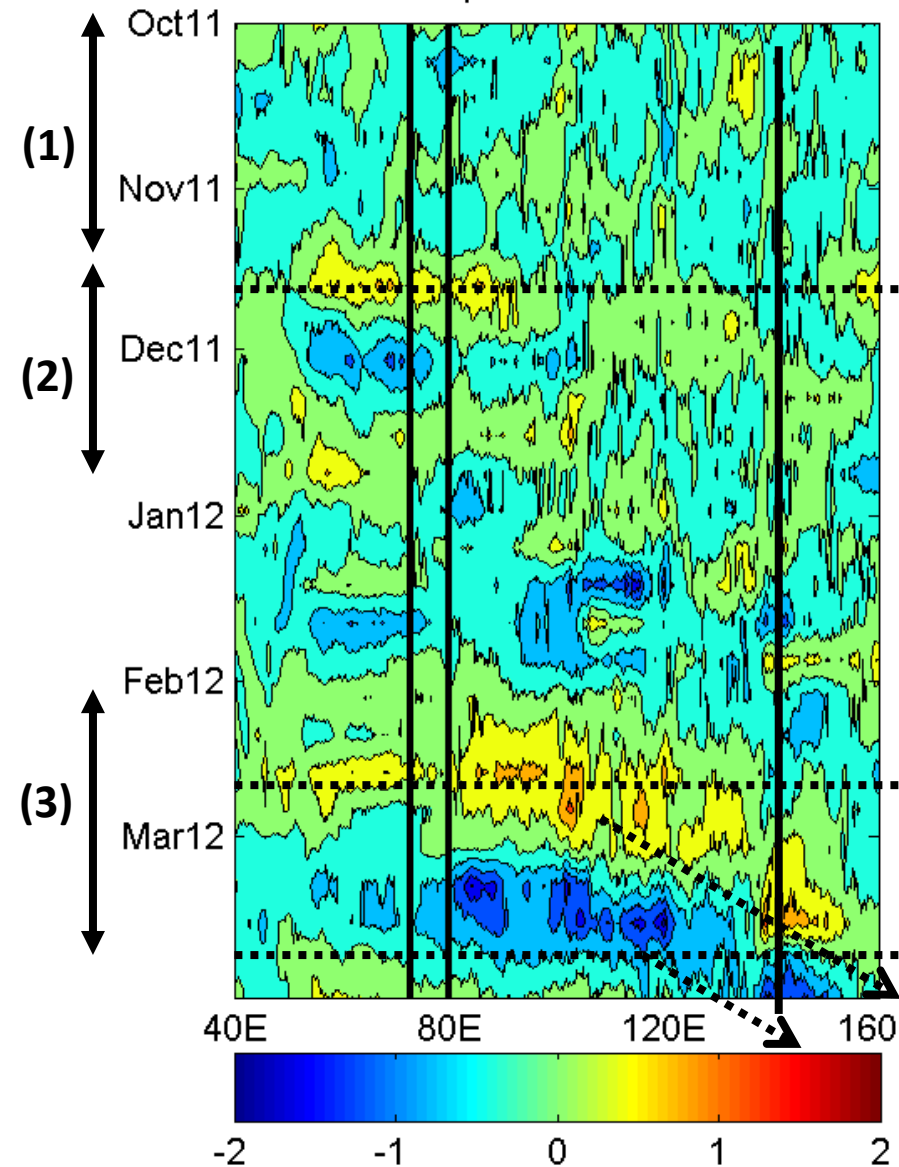# Kelvin, Rossby and MJO modes during DYNAMO

Courtesy C. Schreck

Satellite Observations during DYNAMO

SST

8°S - Eq. subseasonal SST
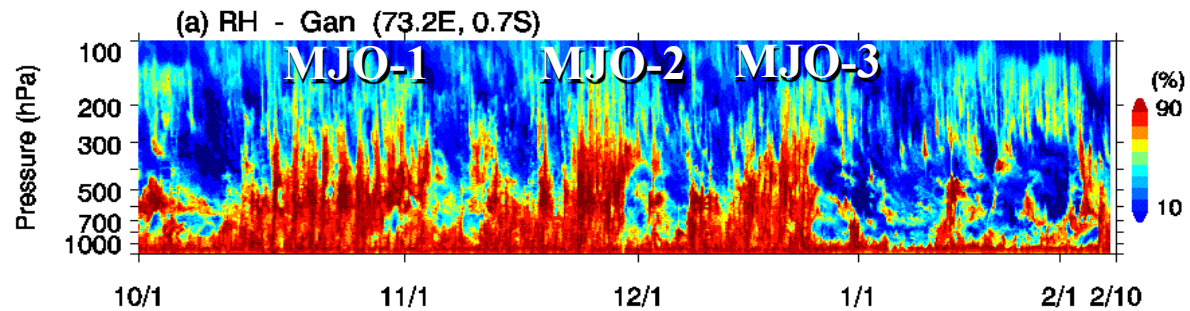
OLR

8°S - Eq. subseasonal OLR

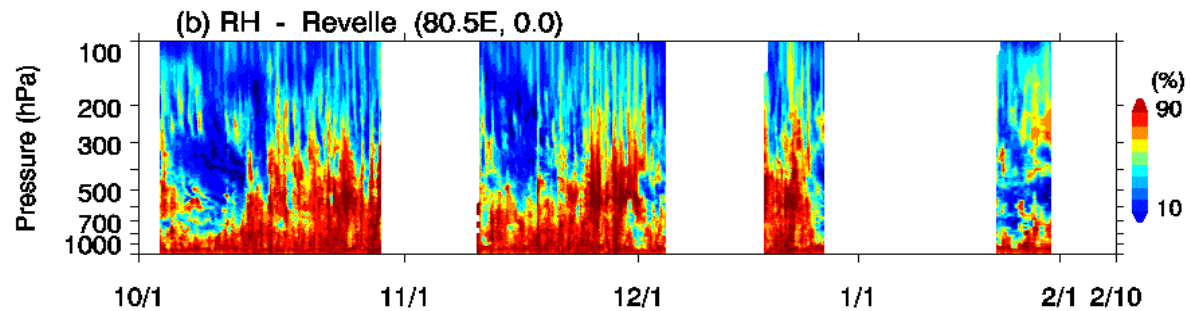(1) – "Uncoupled" period   (2) – "Weekly Coupled" period   (3) – "Strongly Coupled" period
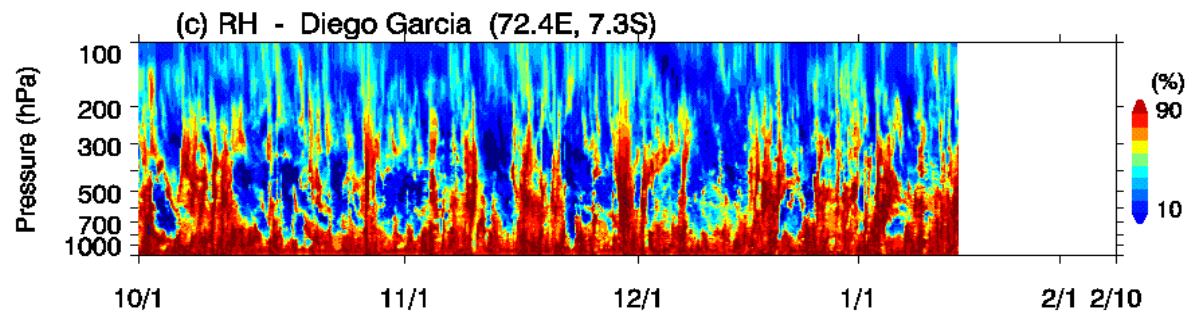
DYNAMO Radiosondes: Relative humidity

(a) RH - Gan (73.2E, 0.7S)

MJO-1   MJO-2   MJO-3

Gan

(b) RH - Revelle (80.5E, 0.0)

R/V Revelle

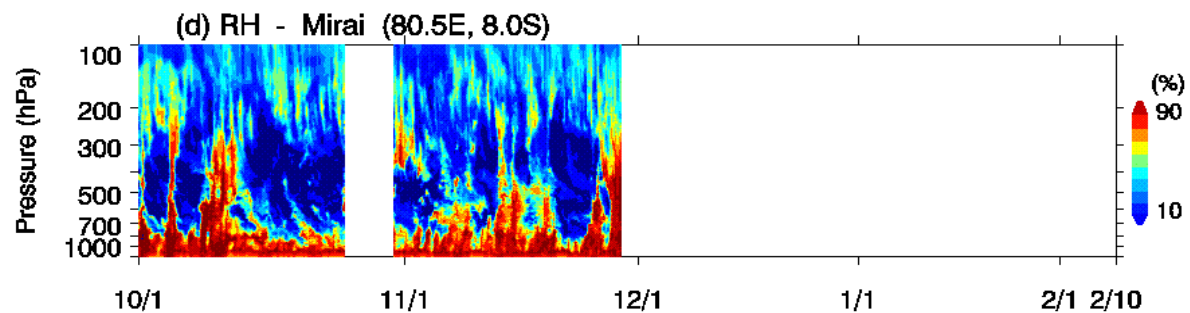(c) RH - Diego Garcia (72.4E, 7.3S)
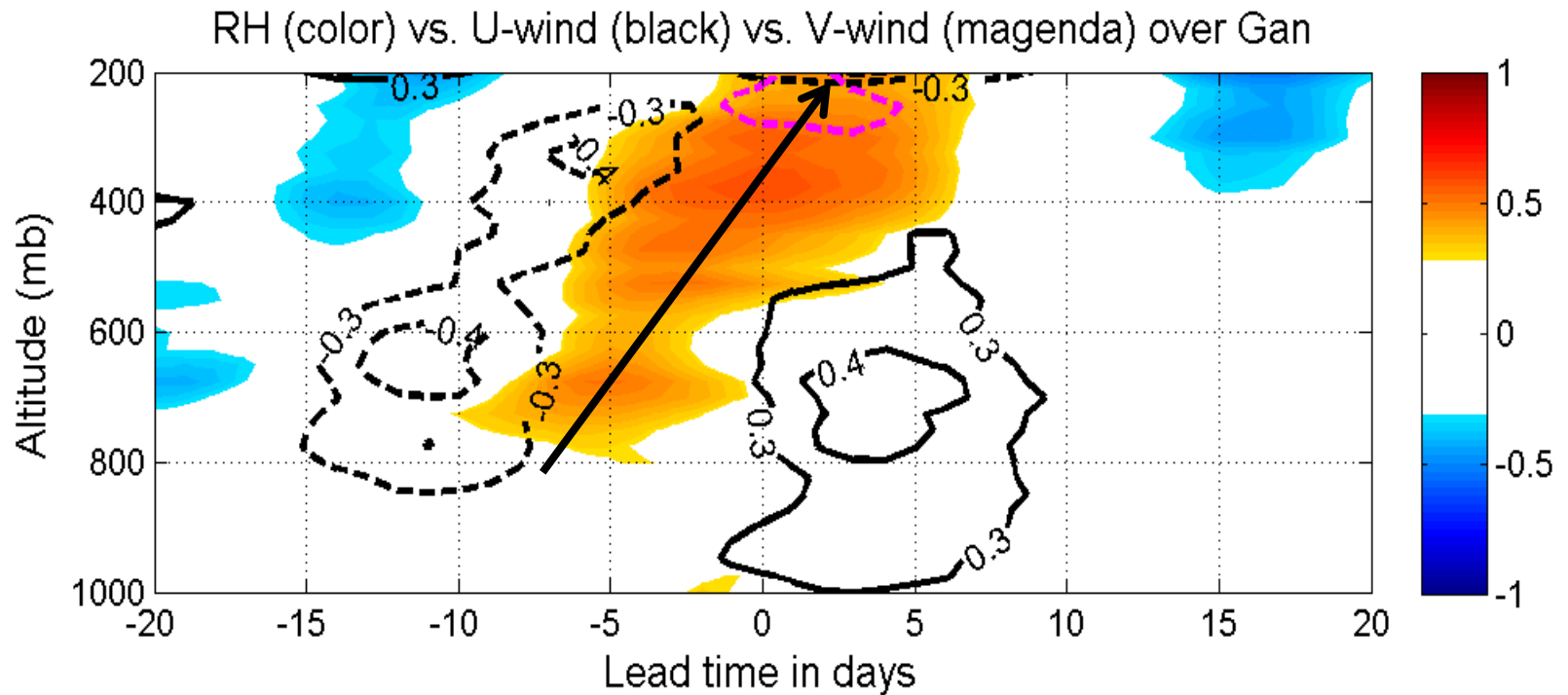
Diego Garcia

(d) RH - Mirai (80.5E, 8.0S)

R/V Mirai

DYNAMO data help to understand the physics of the MJO

Lagged correlations: -RMM2 index (MJO in the Indian Ocean) vs. DYNAMO OBS. (RH and Wind) at Gan Island

RH (color) vs. U-wind (black) vs. V-wind (magenda) over Gan

Observations are indicative of a moisture recharge process as e.g. in Benedict and Randall (2007)
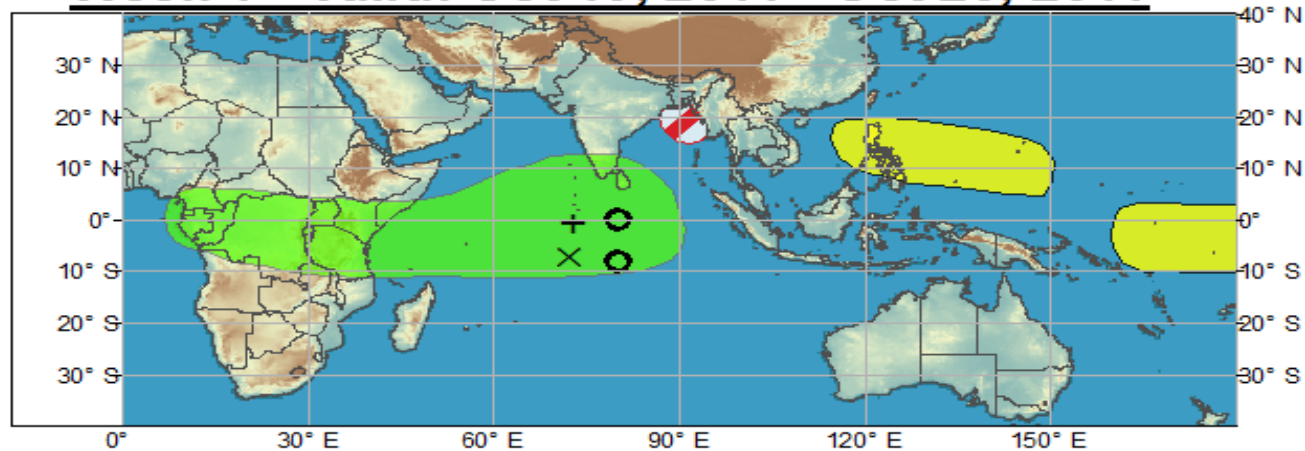
From NCEP to DYNAMO to NCEP

CPO funded the Climate Prediction Center and the University of Maryland/ESSIC to provide monitoring and forecast support to DYNAMO
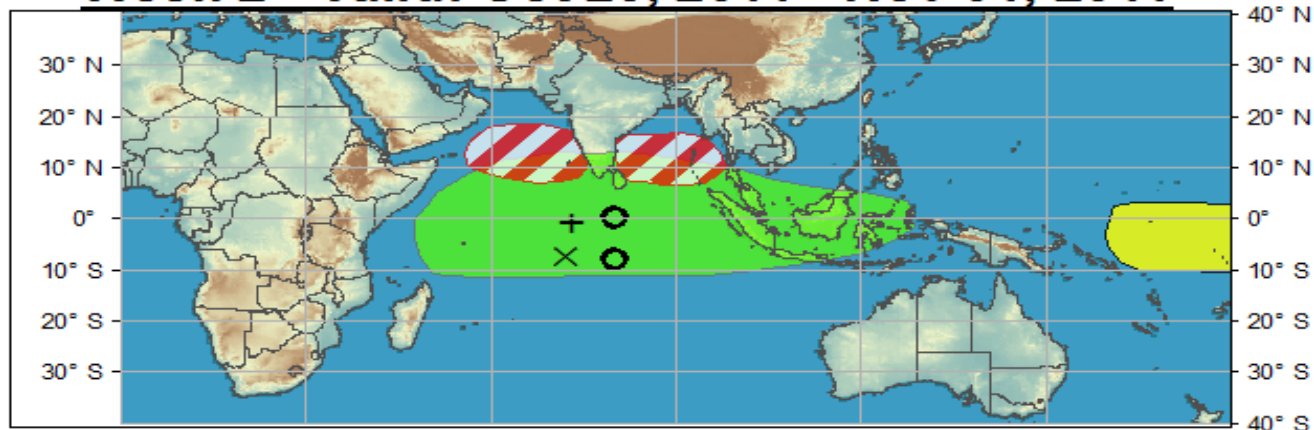
GDAS

CFS - R

GFS - High Res.

GEFS - Ensemble

CFS - Coupled

DYNAMO Tailored Products

Special Weekly CPC - GTH Outlook product (human forecasters)

Data Catalog Earth Observing Laboratory (EOL), NCAR

DYNAMO

Global Telecommunication System
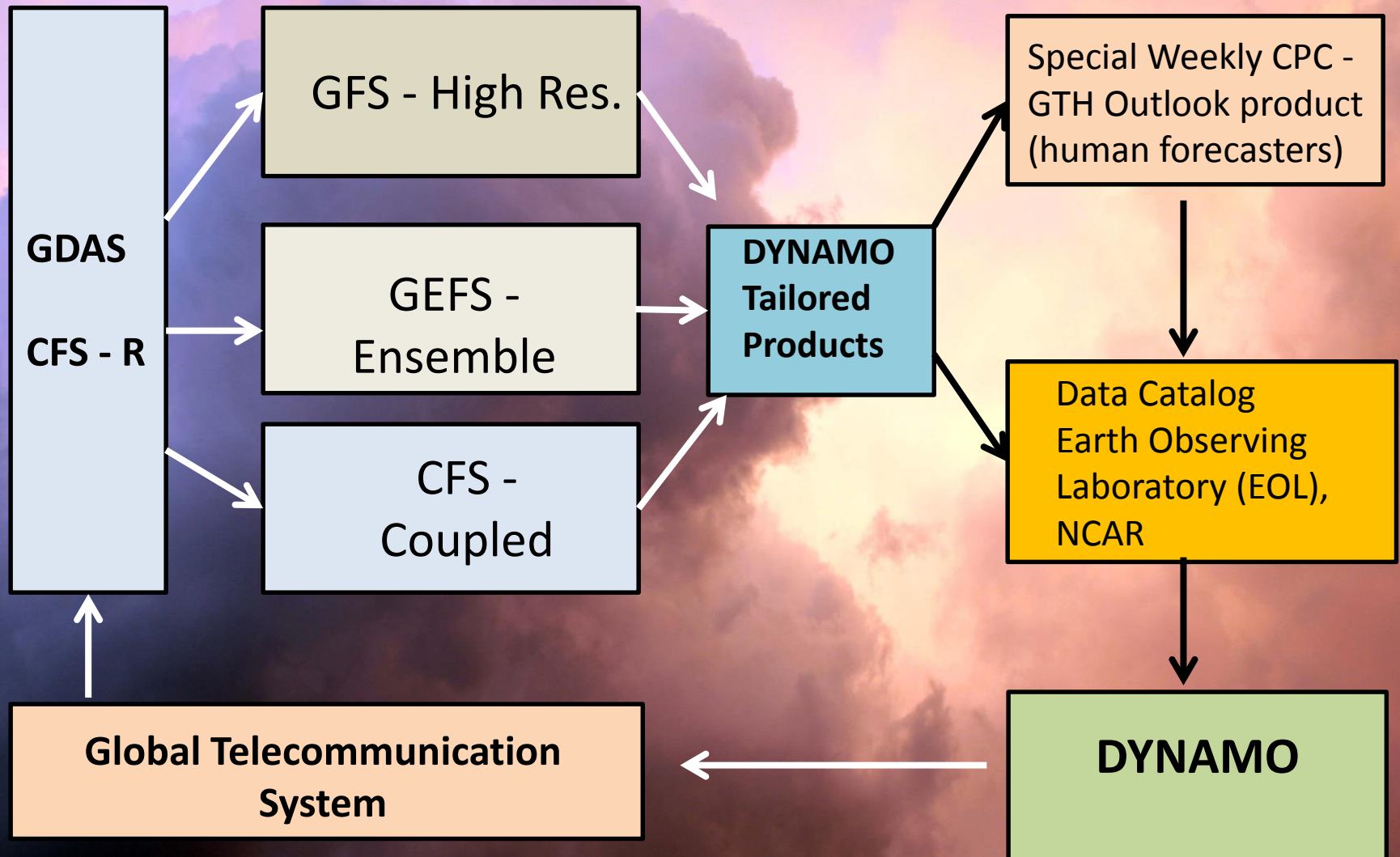
...and to evaluate the NCEP models during DYNAMO

Review of CPC-GTH DYNAMO Outlooks (forecaster team)
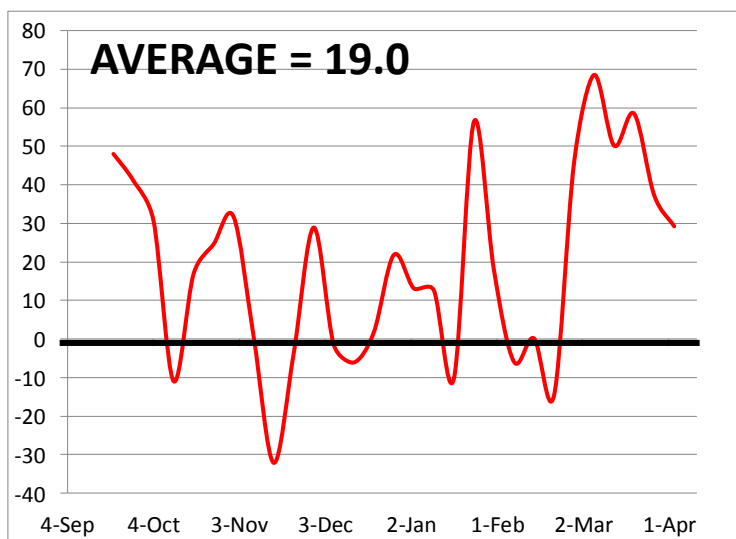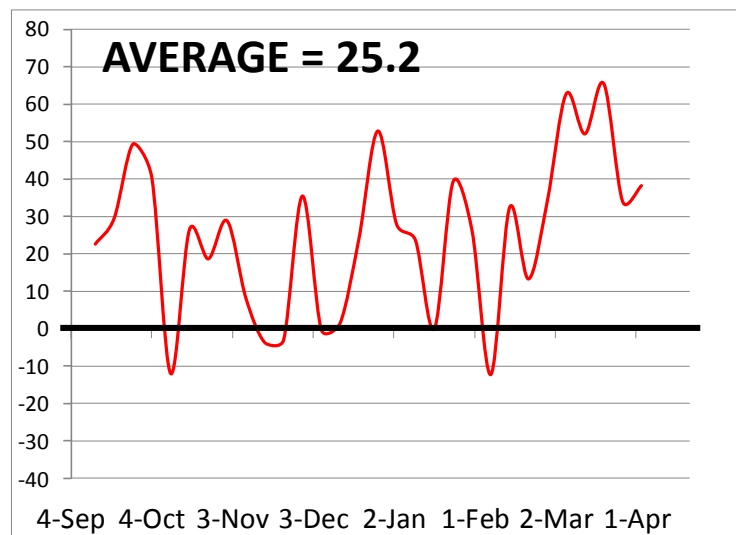

Week 1 - Valid: Oct 19, 2011 - Oct 25, 2011

Week 2 - Valid: Oct 26, 2011 - Nov 01, 2011

Confidence

	High	Moderate	
Tropical Cyclone Formation	(red)	(red hatched)	Development of a tropical cyclone that reaches a max. sustained wind of 63 km/hr.
Above-average rainfall	(green)	(green hatched)	Weekly total rainfall in the upper tercile.
Below-average rainfall	(yellow)	(yellow hatched)	Weekly total rainfall in the lower tercile.

✕ DG   + Gan   ⭕ Ship1   ⭕ Ship2   **Produced: 10/18/2011**

Review of DYNAMO Outlooks: Heidke Skill Score

Time series of Week-1 and Week-2
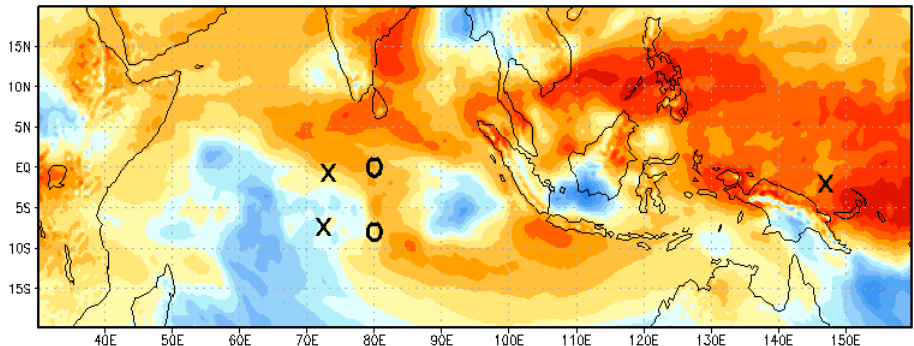

Spatial map of Week-1 and Week-2
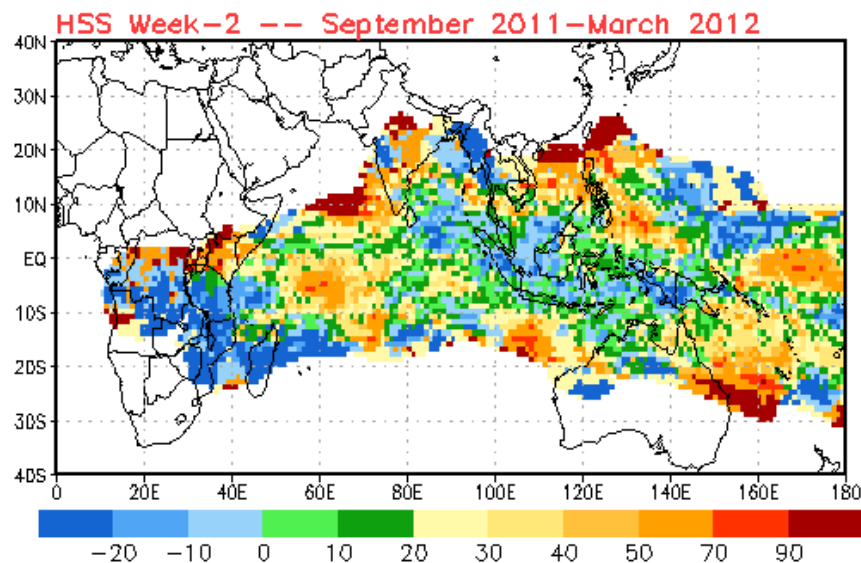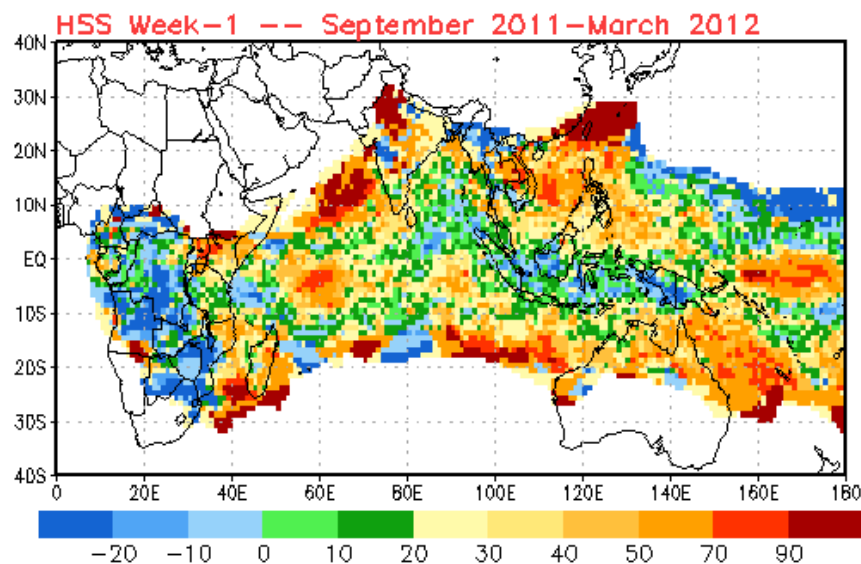
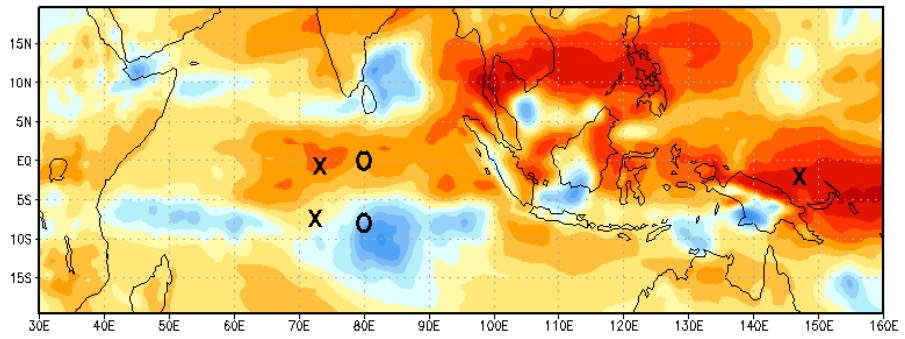# Confronting NCEP models to DYNAMO observations

Forecast of Anomalous OLR (GFS) for the October DYNAMO MJO event

Week 1 — Forecast — Week 2
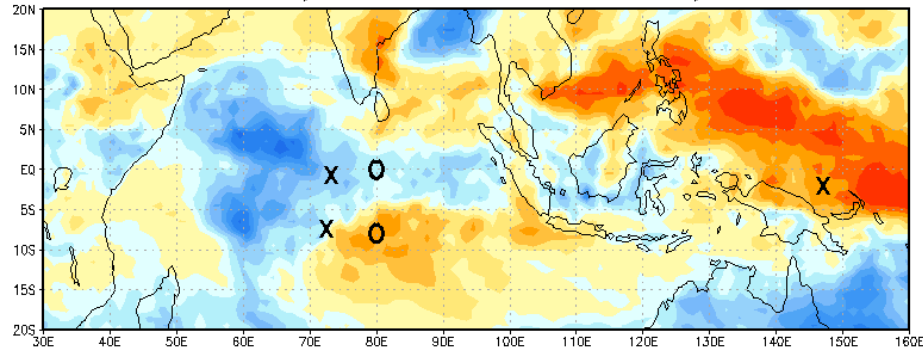

GFS frcst anom. OLR for week 1 from: 20111015all

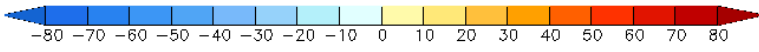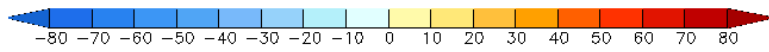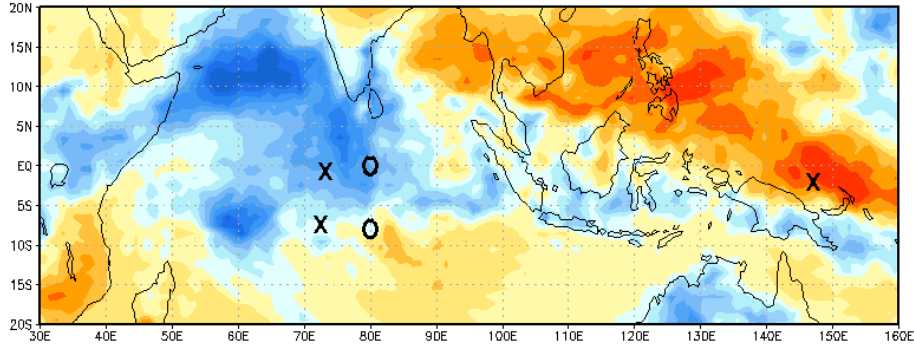GFS frcst anom. OLR for week 2 from: 20111015all

Verification

Observed 7-day mean OLR anom from day 20111016

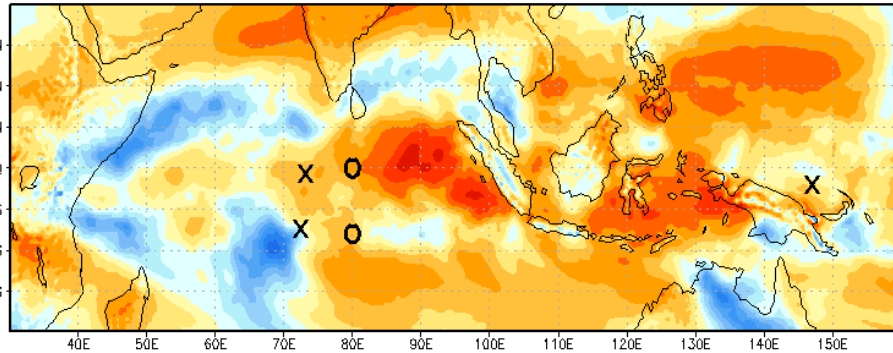Observed 7-day mean OLR anom from day 20111023

Forecast of Anomalous OLR (GFS) for the November DYNAMO MJO
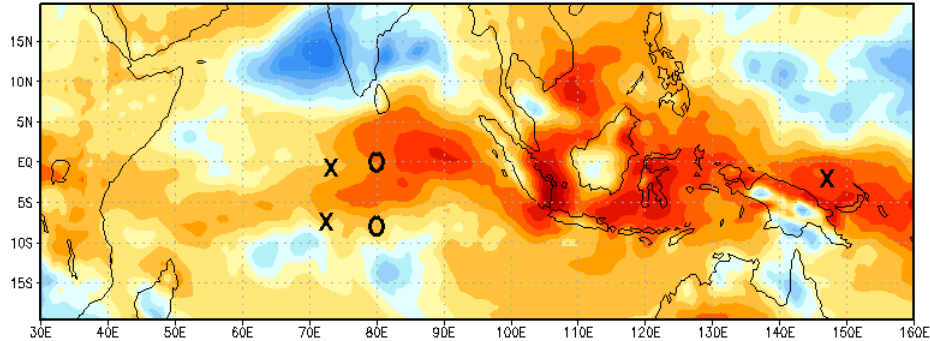
Week 1   **Forecast**   Week 2

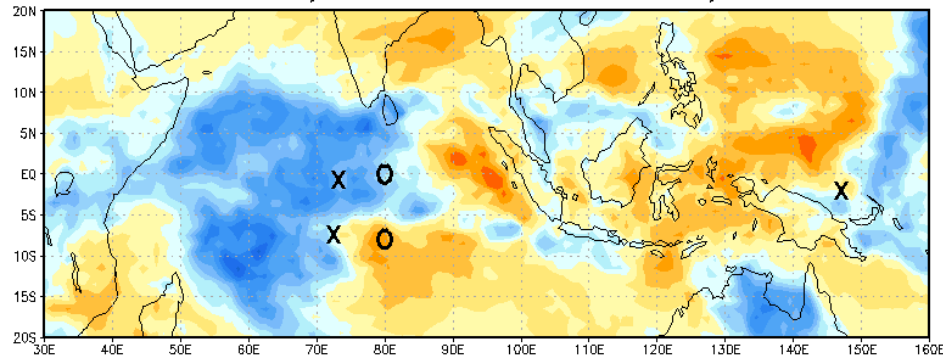GFS frcst anom. OLR for week 1 from: 20111117all

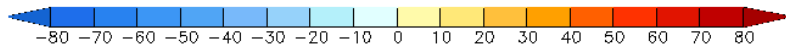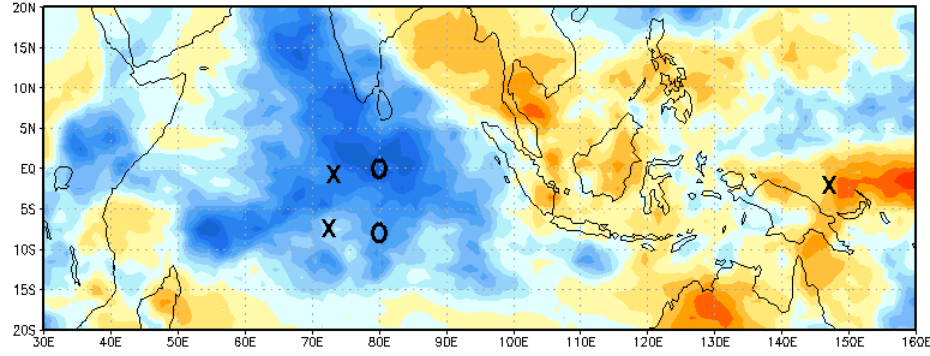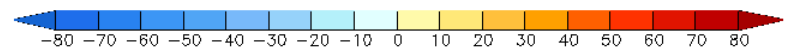GFS frcst anom. OLR for week 2 from: 20111117all

Verification

Observed 7-day mean OLR anom from day 20111118
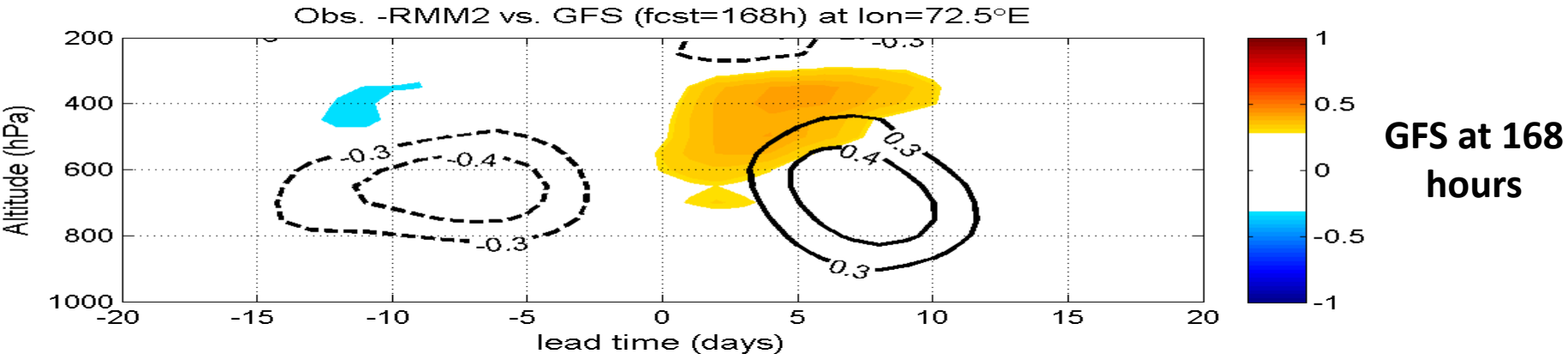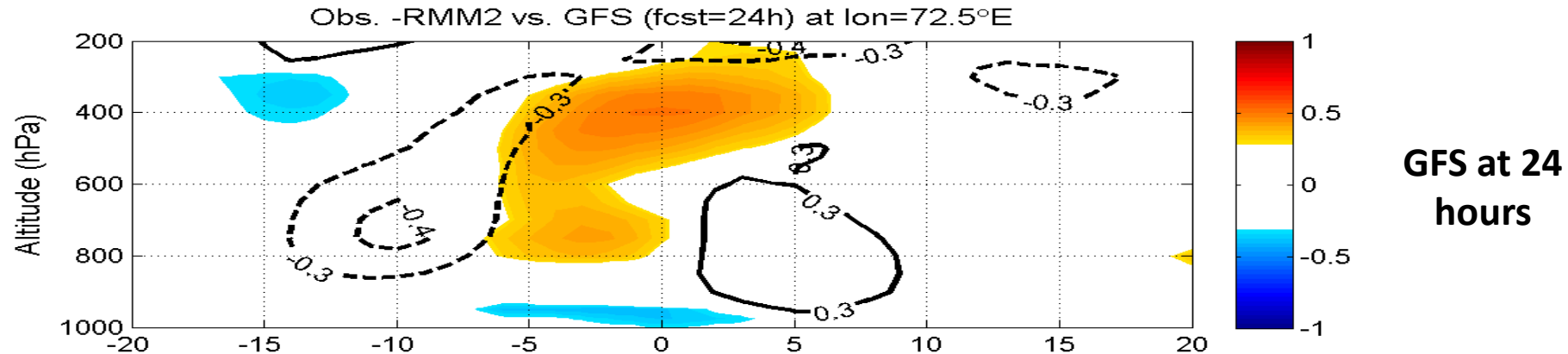

Observed 7-day mean OLR anom from day 20111124
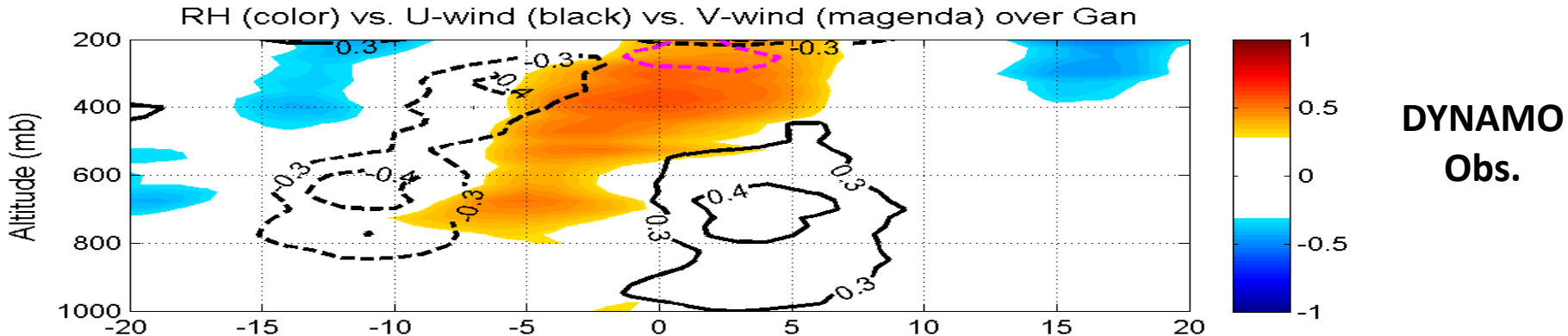
NOAA – Climate Prediction Center

NOAA – Climate Prediction Center

Decoupling of the dynamics and thermodynamics in the GFS

RH (color) vs. U-wind (black) vs. V-wind (magenda) over Gan

DYNAMO Obs.

Obs. -RMM2 vs. GFS (fcst=24h) at lon=72.5°E

GFS at 24 hours

Obs. -RMM2 vs. GFS (fcst=168h) at lon=72.5°E

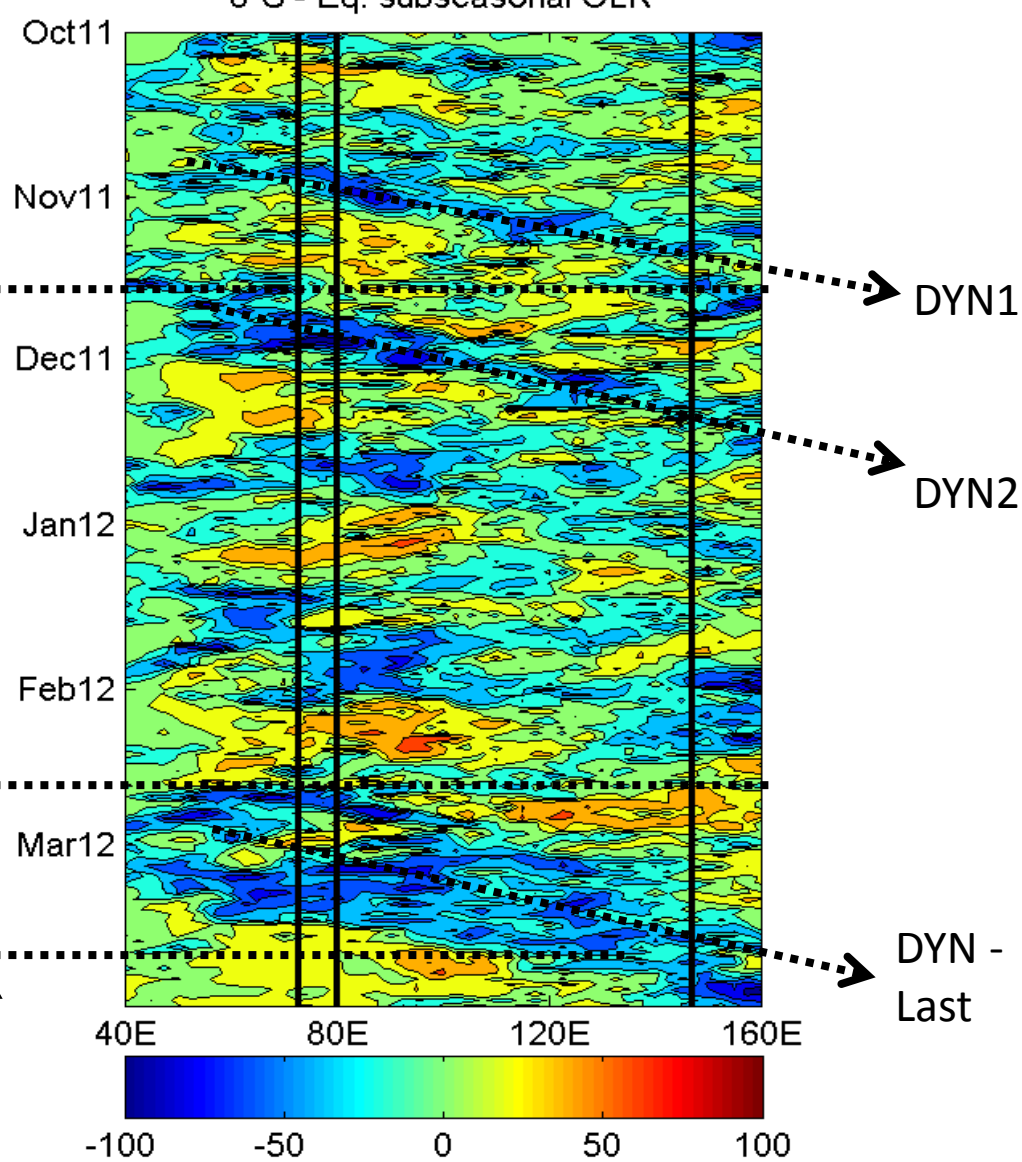**GFS at 168 hours**
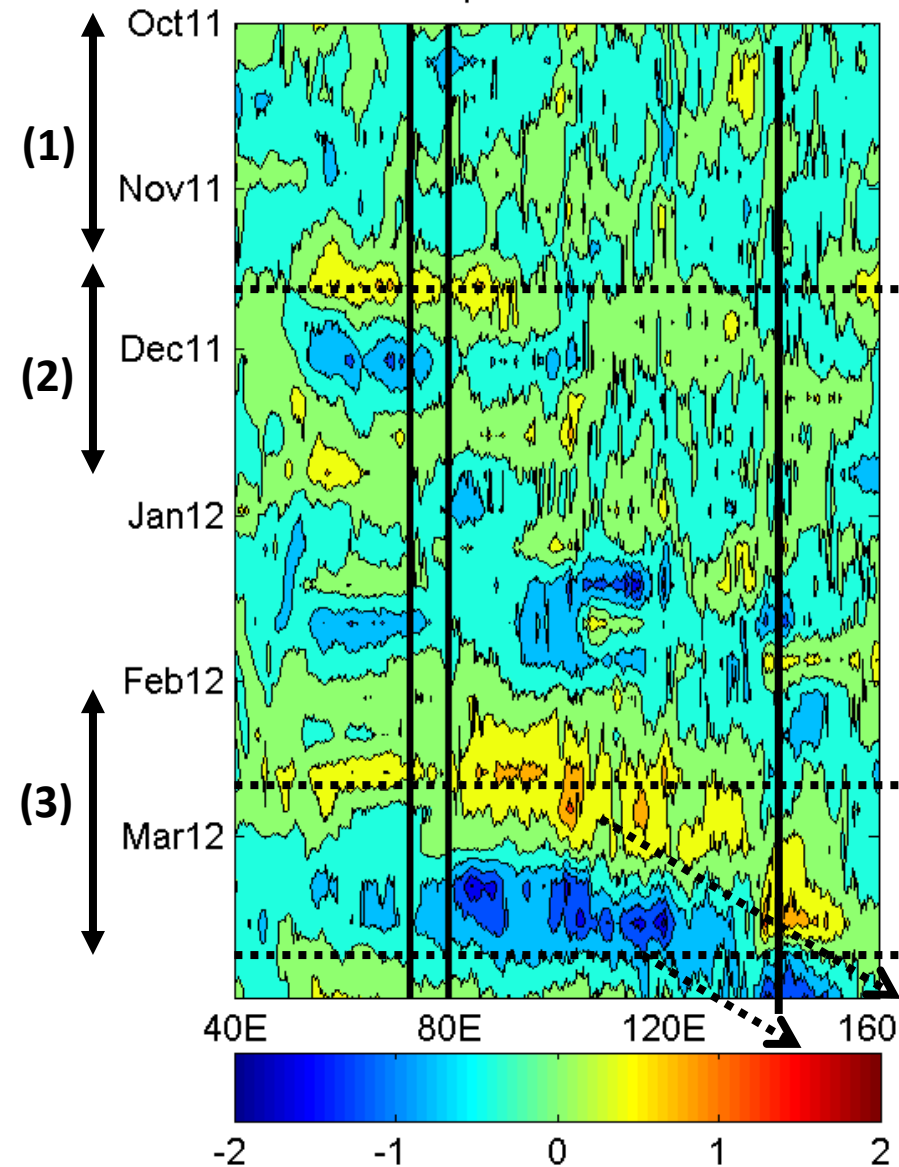
Coupled versus uncoupled forecasts during DYNAMO

Satellite Observations during DYNAMO
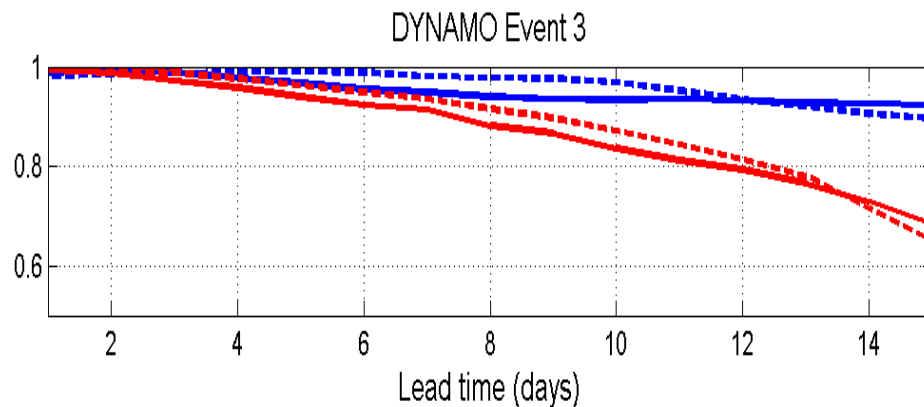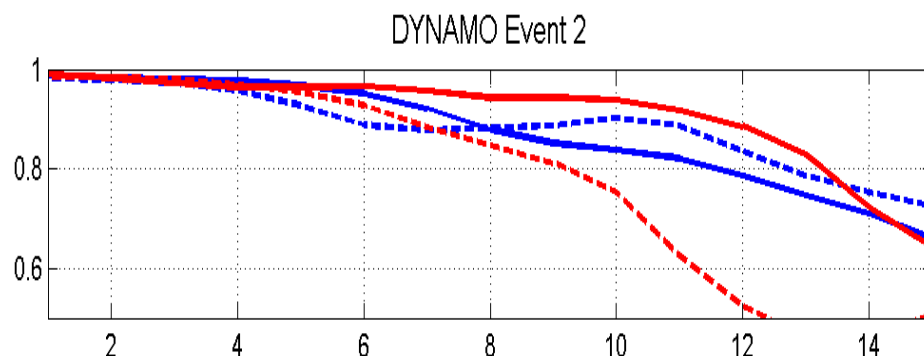
SST — 8°S - Eq. subseasonal SST

OLR — 8°S - Eq. subseasonal OLR

(1) – "Uncoupled" period   (2) – "Weekly Coupled" period   (3) – "Strongly Coupled" period

RMM1 (cont.) and RMM2 (dash) forecast skill for CFS (blue) and GFS (red)

(Correlation period is the same calendar period for each lead time)
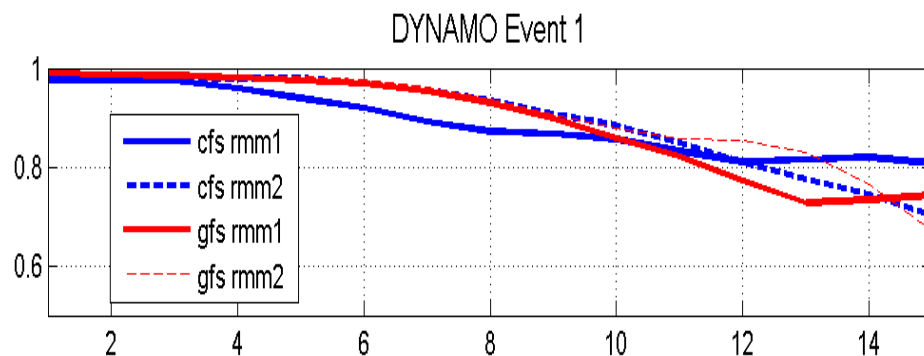
"Uncoupled" DYNAMO-1 event – both CFS and GFS similar skill

"Weakly coupled" DYNAMO-2 event – GFS RMM2 (Indian Ocean) skill drops quickly

"Strongly coupled" DYNAMO-3 event – CFS clearly beats GFS

Oceanic forecasts during DYNAMO

Synopsis of DYNAMO moorings D1 and D2 (courtesy Ren-Chieh Lien)
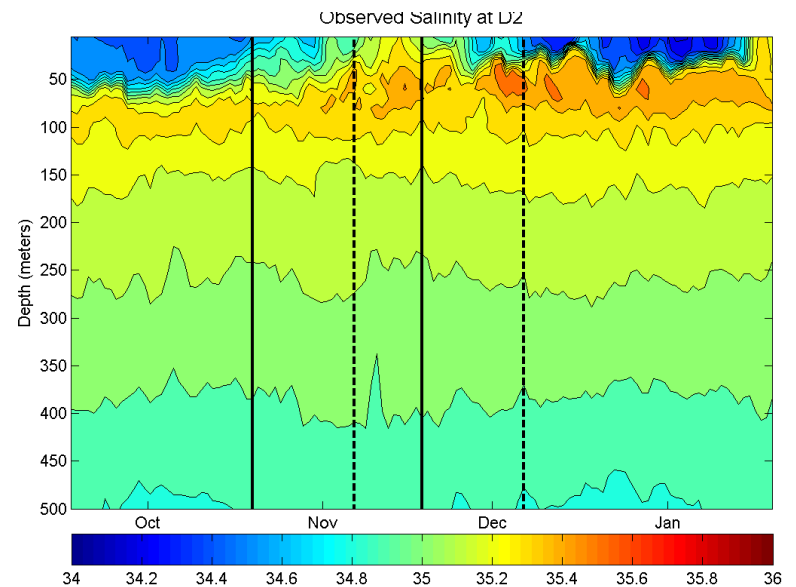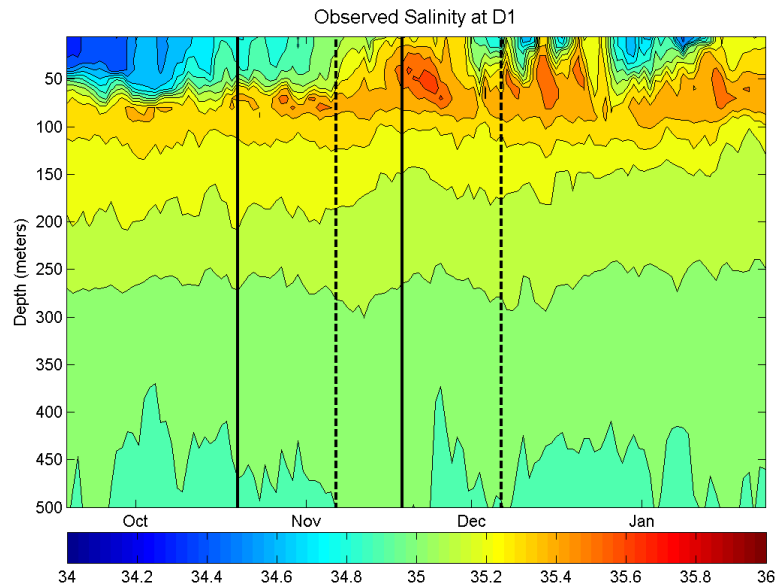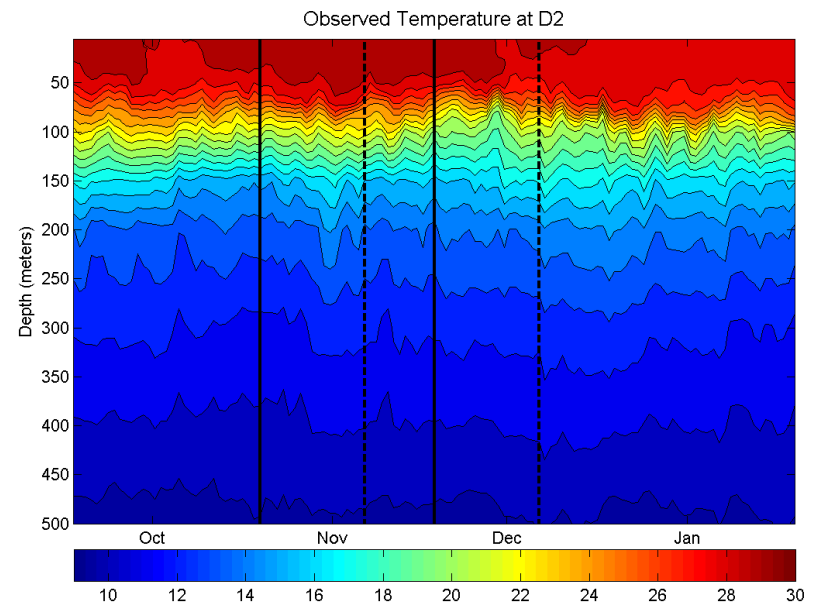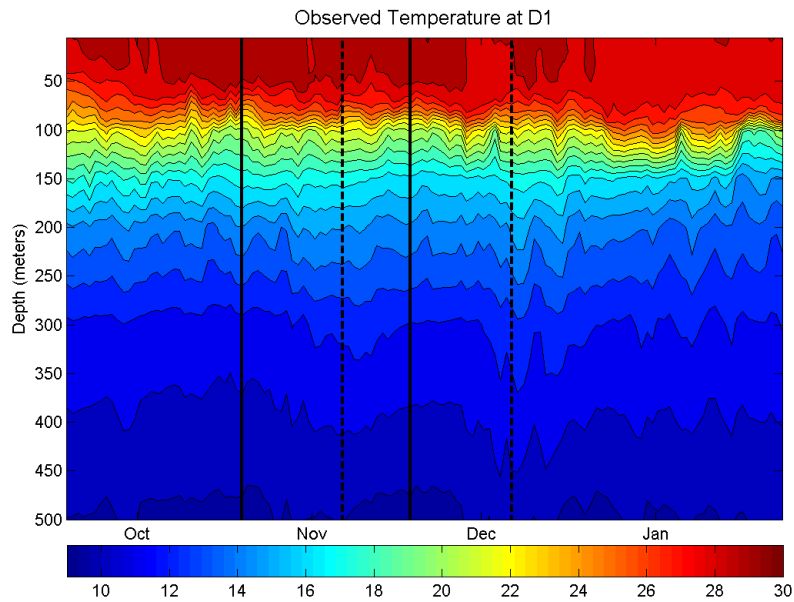
Correlation between observed and CFS forecast Temperature fields

DYNAMO subsurface data were not sent to the GTS

Mooring D1   **Mooring D2**
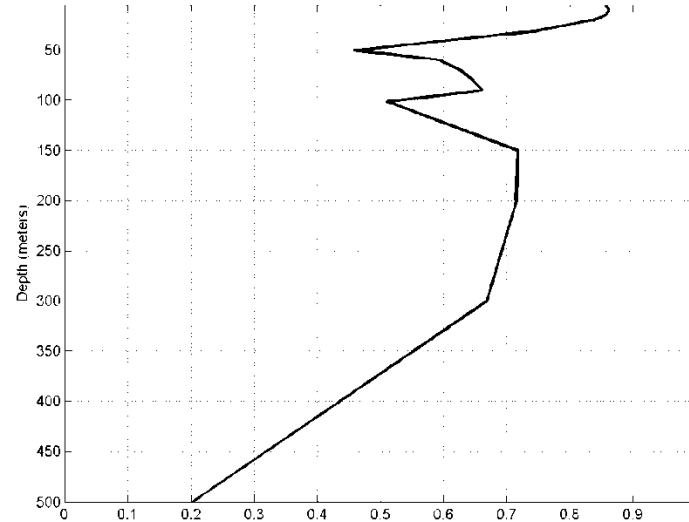
Initialization

CFS-Reanalysis
vs.
DYNAMO
Daily data
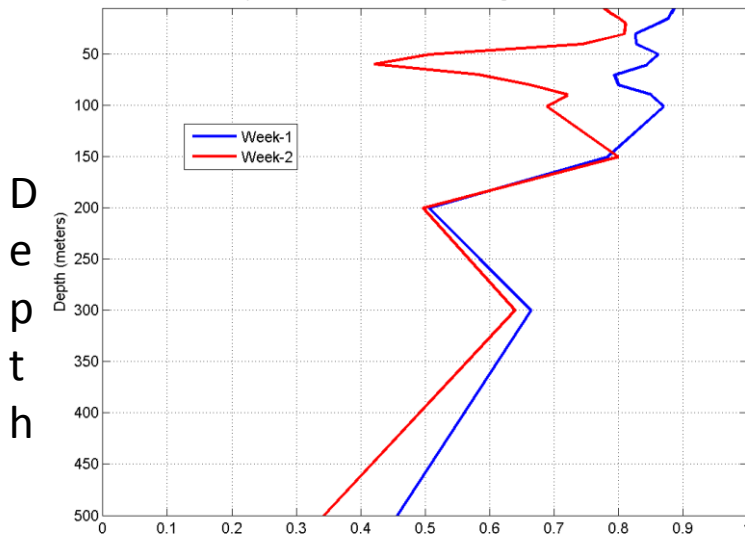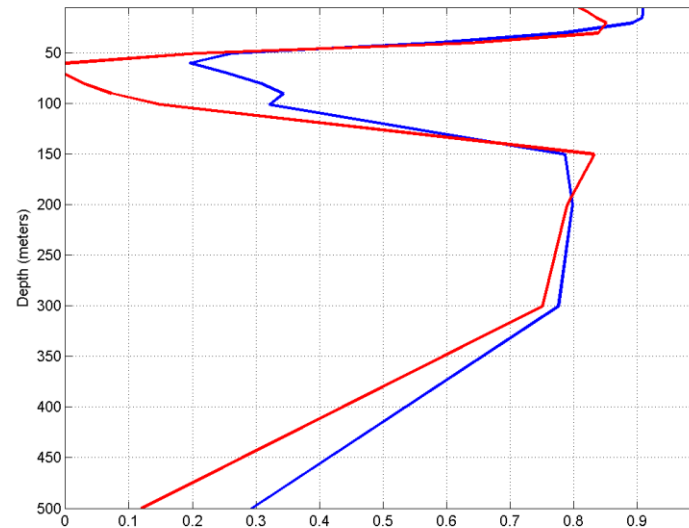
Forecast

CFS-Forecast
vs.
DYNAMO
Weekly data

Very important drop in skill at the depth of the mixed layer – may affect forecast for > week 2

Summary and conclusions:

- NCEP and ESSIC provided real-time monitoring and forecast support to the DYNAMO campaign
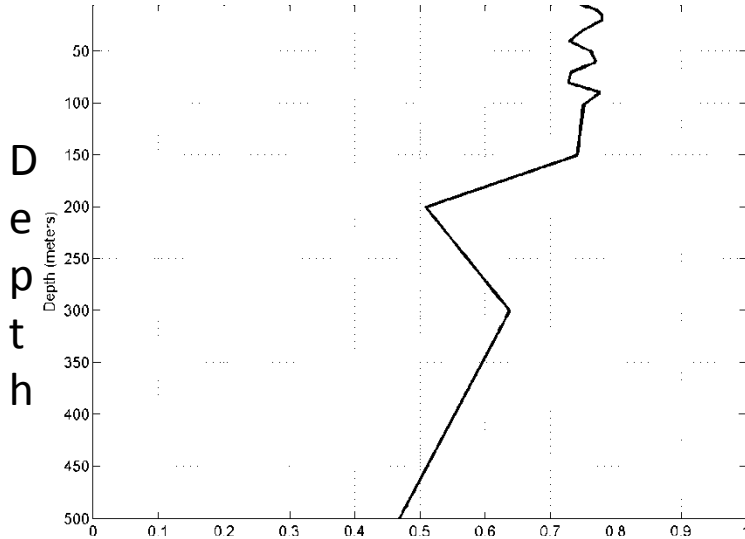
- The team of forecasters issued skilful Week-1 and Week-2 outlooks of specifically tailored products

- In the GFS model we noted a fast decoupling between the dynamics and thermodynamics of the MJO hampering the eastward propagation of large scale convection

- There are times when convection and SST are evolving in a coherent way. During these times the coupled CFS presents a better skill than the uncoupled GFS.

- The ocean model presents a very fast drop of forecast skill at the base of the mixed layer with possible impacts to the forecast of SST for Week-3 and Week-4

Work to follow:

- Systematic investigation of the capacity of different models to represent the individual physical sources of subseasonal predictability i.e., Kelvin, Rossby and MJO modes. Research on optimal multi-model consolidation.

- The success of the team of forecasters indicates that many improvements can be made in the models:

  - Investigate reasons for the de-coupling between thermodynamics and dynamics in the GFS

  - Investigate predictability of SST at Week-3 and Week-4 and examine the ocean mixed layer as source of errors.

- Use the finding to enhance forecast skill of the Global Tropics Hazards and Benefits Outlook (GTH) tool. Extend the GTH to Week-3 and Week-4.

Example of GTH Outlook issued October 16th: Tropical Cyclone Sandy

Global Tropical Hazards/Benefits Outlook - Climate Prediction Center
Week 1 - Valid: Oct 17, 2012 - Oct 23, 2012
Week 2 - Valid: Oct 24, 2012 - Oct 30, 2012

Sandy

Produced: 10/16/2012
Forecaster: Pugh

Confidence	High	Moderate	
Tropical Cyclone Formation			Development of a tropical cyclone that eventually reaches tropical storm/cyclone strength.
Above-average rainfall			Weekly total rainfall in the upper third of the historical range.
Below-average rainfall			Weekly total rainfall in the lower third of the historical range.
Above-normal temperatures			7-day mean temperatures in the upper third of the historical range.
Below-normal temperatures			7-day mean temperatures in the lower third of the historical range.

Product is updated once per week. The product targets broad scale conditions integrated over a 7-day period for US interests only. Consult your local responsible forecast agency.
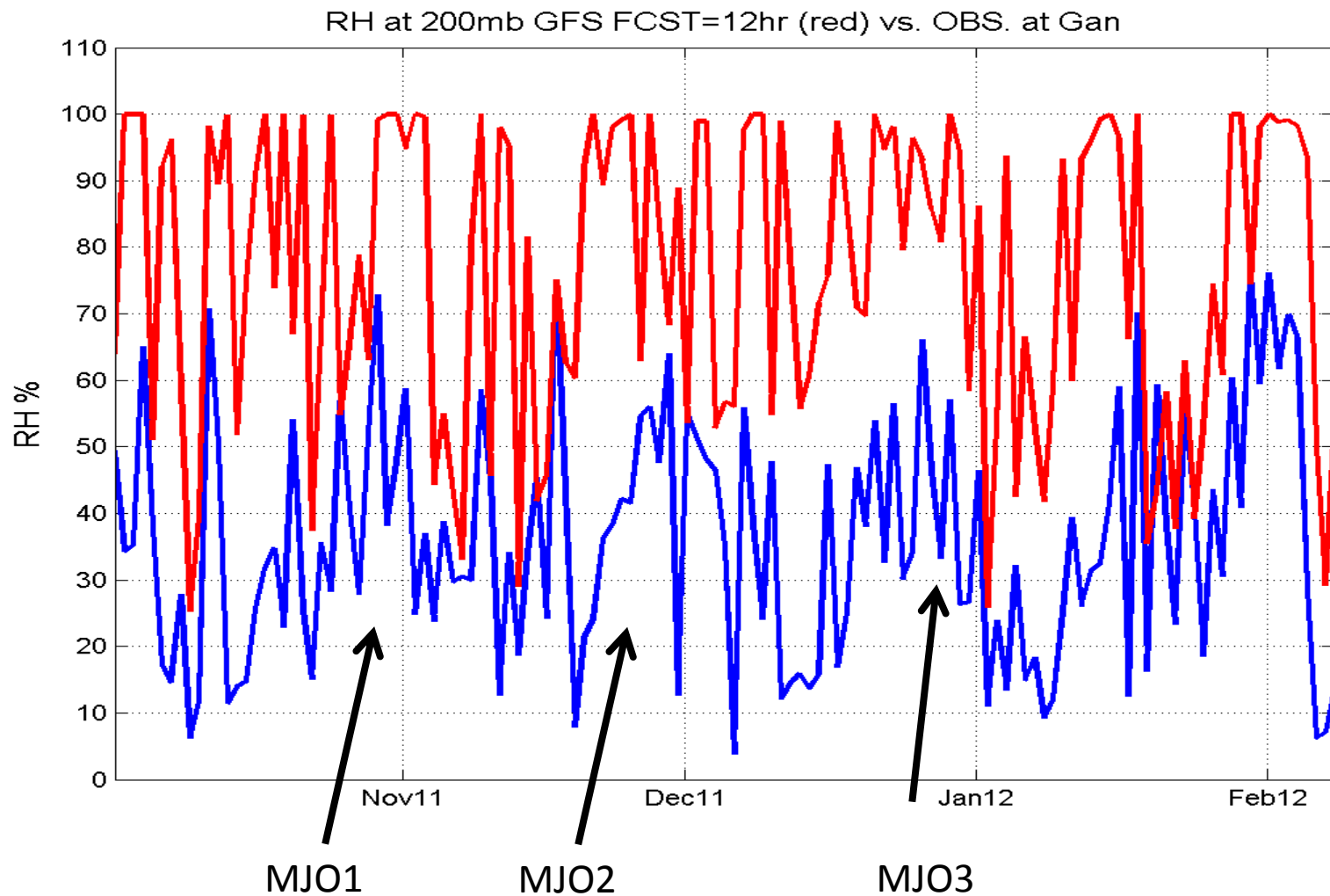
Questions?

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200 hPa Relative Humidity at Gan: DYNAMO (blue) and GFS at fcst=12h (red)

RH at 200mb GFS FCST=12hr (red) vs. OBS. at Gan

WH04 MJO Index Forecast Skill

September 2011 – March 2012